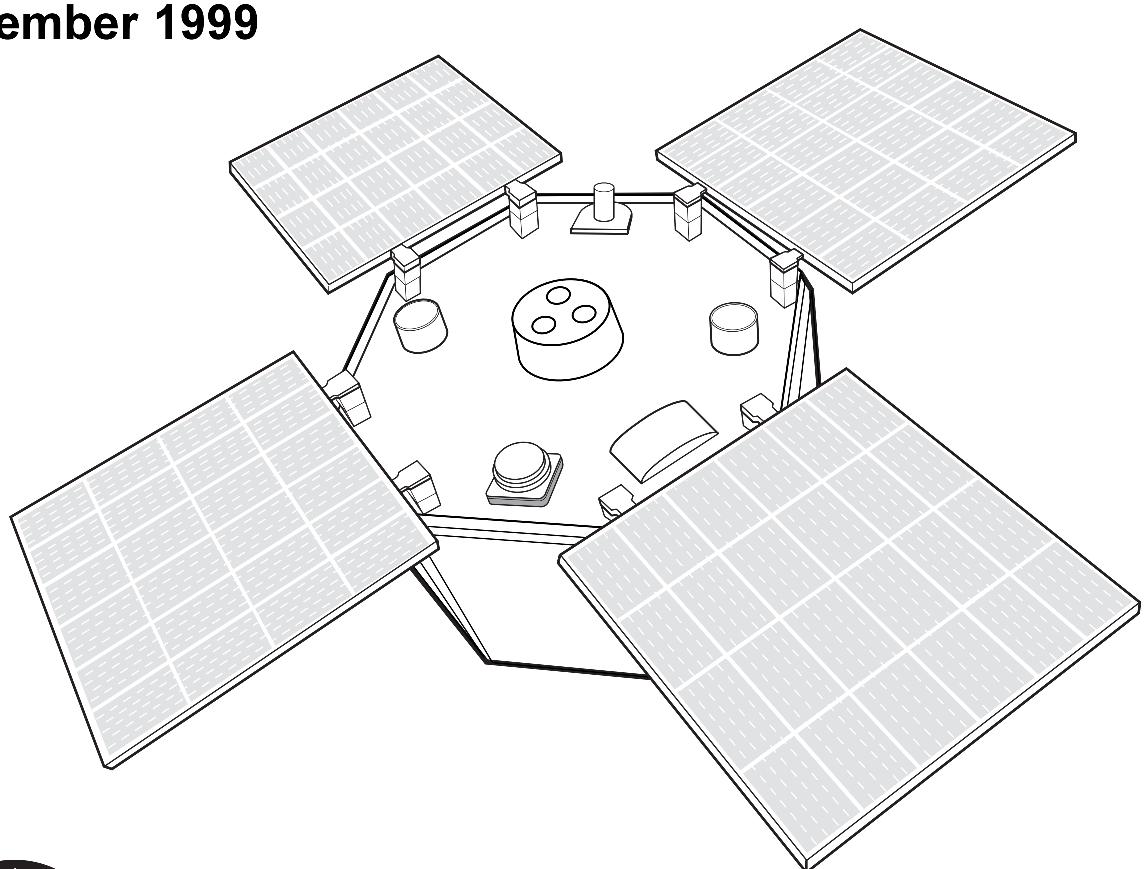
NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

# AcrimSat Launch

**Press Kit**
**December 1999**



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## Contents

**RELEASE:**

**NEW ORBITING RADIOMETER WILL MEASURE SUN'S RADIANT POWER**

Launch of NASA's new Active Cavity Radiometer Irradiance Monitor (AcrimSat) on December 20 will continue the agency's multi-year effort to measure the total amount of sunlight which falls on Earth's atmosphere, oceans and land, and determine whether an increase in sunlight is contributing to a rise in global temperatures.

"Small, sustained changes in total solar output of as little as a quarter of one percent per century could become the primary cause of significant climate change on time scales of many decades," said Dr. Richard Willson, principal investigator for the instrument at Columbia University, New York, NY. "The information we receive will be critical to understanding Earth's present climate and the possibility of climatic changes and global warming in the long-term."

The Sun's 11-year solar cycle of maximum and minimum activity has been confirmed by previous space missions. However, the causes of these variations and their magnitudes are largely unknown. Small, sustained changes in the Sun's overall energy output may play a significant role in global warming and other climate changes, such as El Niños and La Niñas.

The small, 253-pound (115-kilogram) satellite will measure the Sun's total energy output. It will be launched on a Taurus expendable launch vehicle from Space Launch Complex 576 East at Vandenberg Air Force Base, CA, during a 16-minute window opening at 11:07 p.m. Pacific Standard Time on December 20. The Taurus rocket will deploy its primary payload, the Korea Multi-Purpose Satellite, 14 minutes after launch. About 90 seconds later, the vehicle will release the second payload, AcrimSat, which will circle Earth from a polar orbit at an altitude of 425 miles (685 kilometers).

Scientists theorize that a significant fraction of the Earth's global warming may be solar in origin due to small increases in the Sun's total energy output since the last century. By measuring incoming solar radiation and adding measurements of ocean and atmosphere currents and temperatures, as well as surface temperatures, climatologists will be able to improve their predictions of climate change and global warming over the next century.

Changes in the total solar irradiance have caused major climate changes in the past, ranging from the creation of ice ages to global tropical climates in which all "permanent" ice on Earth disappeared, even at the poles. Sustained changes of as little as one-fourth of one percent may have been the cause of significant climate changes such as Earth's "little ice age," which caused worldwide temperatures to drop about 3 degrees F (1.5 degrees C) lower than today's temperatures.

Data from AcrimSat will help scientists gather information on a daily basis to build accurate mathematical models of Earth's climate system. The models, in turn, will help them understand and predict the response of the climate to natural events and human activities. Data will also aid them in understanding how Earth's atmosphere will respond to increasing amounts of inbound solar radiation and the accumulation of greenhouse gases in the next century.

The Active Cavity Radiometer Irradiance Monitor instrument, built by NASA's Jet Propulsion Laboratory, Pasadena, CA, is managed by JPL for NASA's Office of Earth Sciences, Washington, DC. Columbia University's facility at Coronado, CA, will oversee science operations. The primary ground station is located at JPL's Table Mountain Observatory in Wrightwood, CA. Orbital Sciences Corp., Dulles, MD, built the Taurus launch vehicle and AcrimSat satellite.

NASA's Earth Sciences Enterprise is a long-term research and technology program designed to examine Earth's land, oceans, atmosphere, ice and life as a total integrated system. JPL is a division of the California Institute of Technology, Pasadena, CA.

[End of General Release]

# Media Services Information

### NASA Television

The AcrimSat launch will not be broadcast live on NASA Television. Video will be available, however, following the launch; the schedule is posted on the Internet as noted below. NASA Television is broadcast on the satellite GE-2, transponder 9C, C band, 85 degrees west longitude, frequency 3880.0 MHz, vertical polarization, audio monaural at 6.8 MHz.

### Status Reports

Status reports on AcrimSat will be issued by the Jet Propulsion Laboratory's Media Relations Office. They may be accessed online as noted below.

### Pre-Launch Briefing

A pre-launch news briefing is scheduled at 10 a.m. PST Monday, December 20, 1999, in the NASA briefing room in Building 840 at Vandenberg Air Force Base, CA.

### Internet

Information on AcrimSat, including an electronic copy of this press kit and status reports, is available from the Jet Propulsion Laboratory's World Wide Web home page at **http://www.jpl.nasa.gov/** . The AcrimSat project maintains a public home page at **http://acrim.jpl.nasa.gov** . The NASA Television schedule is available at **http://www.nasa.gov/ntv** .

# Quick Facts

**AcrimSat Spacecraft**
Dimensions: Main structure octagon 30.5” (77.5 cm) wide, 26” (66 cm) high; total span with solar arrays deployed 70” (178 cm)
Weight: 254 pounds (115 kg)
Power: Solar arrays providing up to 80 watts

**Acrim III Science Instrument**
Weight: 29 pounds (13 kg)
Power Usage: 10 watts

**Mission**
Launch: December 20, 1999, at 11:07 p.m. PST from Space Launch Complex 576 East, Vandenberg Air Force Base, CA
Launch vehicle: Taurus
Orbit: Sun-synchronous at altitude of 425 miles (685 km)
Primary mission: Five years

**Program**
Cost: $10M spacecraft and ground stations; $3M science instrument; $4.5M upgrade of Table Mountain Observatory and program management/monitoring; $17.5 million total

# Why Study the Sun's Energy?

AcrimSat is designed to monitor the total amount of the Sun's energy entering Earth's atmosphere-ocean system. It is this solar radiation, called total solar irradiance, that creates the winds, heats the land and drives ocean currents. Climate scientists use measurements of the total input of solar energy being delivered to Earth's atmosphere, oceans and land, along with measurements of temperatures and ocean and atmospheric circulation, to construct mathematical models that better predict global temperatures and the climate behavior of the planet. The data are also important in distinguishing the effects of human activity from the effects of variations of the Sun's energy output on Earth's atmosphere and climate.

Satellite observations of the Sun's rotation show that this star generates huge magnetic fields which shape active regions, produce sunspots and sculpt massive loops and prominences at the peak of an 11-year solar cycle. Solar luminosity is closely linked to these 11-year peaks and lows in solar activity, with the next peak expected in 2001-2002.

About 70 percent of the Sun's incoming energy is absorbed in Earth's atmosphere, surface and oceans. The rise in total solar irradiance levels, coupled with steadily rising solar activity as the Sun nears its most active phase, is considered an important factor in global warming on time scales of decades to centuries.

Greenhouse gases created by human activity are believed to be the dominant influence in global warming. Greenhouse warming is expected to raise temperatures on Earth by about 4 degrees F (about 2 degrees C) over the next 50 to 100 years. If the total solar irradiance trend discovered by previous space radiometers continues, the Sun's effect on long-term climate may account for between one-fourth to one-half of this warming. Looking back to 1880, scientists have already observed an increase of about 2 degrees F (almost 1 degree C) in worldwide temperatures. This has paralleled a concurrent rise in solar activity over the period, which implicates rising total solar irradiance levels as a contributing factor.

Fundamental solar variability has caused global climate changes in the past, ranging from ice ages to tropical climates without permanent ice. Scientists believe that sustained changes of as little as one-quarter of one percent may have been the cause of significant climate change in the past on time scales of centuries. The most recent example was a "little ice age" that lasted from the middle of the 1600s to the early 1700s. That ice age lowered today's average worldwide temperatures by as much as about 3 degrees F (1.5 degree C).

The Sun's energy output has been monitored continuously with high precision by NASA and National Oceanic and Atmospheric Administration (NOAA) instruments since 1978. The majority of this database has been provided by results from two previous Active Cavity Irradiance Monitor experiments: the Solar Maximum mission of 1980-1989, which carried the first such radiometer, and the Upper Atmosphere Research System (UARS) satellite launched in 1991, which is still operating and carries the second radiometer in the series.

Total solar irradiance is difficult to measure with absolute certainty. Its effects on world climate are difficult to determine since the shortest known cycles are about 200 years. The capabilities of satellite technology to observe solar variability are limited by the satellite's operational life times and the gradual degradation of solar monitoring sensors over time. A careful measurement strategy is required to produce a total solar irradiance database of sufficiently long duration and precision.

An adequately precise database of measurements is possible using an overlapping satellite solar monitoring strategy. Solar monitors must be launched with sufficient frequency to provide overlapping observations to calibrate the database at the level of instrument precision. NASA's series of active cavity radiometers was designed with this in mind. Each new monitor will begin its mission while another one is still operating to prevent interruptions in high-precision data gathering necessary to observe solar variability. Continued study of the Sun's influence on climate change and global warming would require the flight of many such solar monitors over century-length timescales with overlapping missions.

The use of total solar irradiance data in climate modeling has been identified by the U.S. Global Change Research Program as essential in determining climate shifts, atmospheric variability and changes that may be necessary to protect Earth's climate system. These shifts in global climate are occurring faster than ever before, and are the result of both natural processes and human activities. The Sun, however, remains primary source of energy for Earth's climate and changes that occur.

"Solar Influences on Global Change," one of the seven research elements of the U.S. Global Change Research Program, has as its primary objectives to monitor total solar irradiance and luminosity in different wavelengths of light with sufficient precision and duration to provide climate databases. The research effort is aimed at determining the physical causes of both solar variability and climate change. The program also advances new theoretical and statistical predictions of solar variability and climate fluctuations.

Solar physicists use measurements of solar variability to help them understand more about the interior structure of the Sun, the solar cycle and the effects of increased solar activity during each 11-year cycle.

The results of the first monitor, launched in 1980, showed that variations of total solar irradiance were proportional to solar activity levels. This enabled scientists to correlate historical records of solar activity with climate change and pointed to variations of total solar irradiance as the cause.

Significant new insights in the solar physics of active regions on the Sun were also derived from the first active cavity radiometer instrument observations. Data from the instrument showed a decrease in total solar irradiance caused by sunspots and increases caused by bright spots associated with magnetically active regions. Data also revealed the evolutionary behavior of active solar regions during the 11-year cycle and showed a 0.1 percent solar cycle variation in luminosity. The combined results of the first and second monitors showed a slow but steady upward trend in total solar irradiance between successive quiet phases of the Sun's solar cycle in 1986 and 1996. This trend, if sustained over century-length time scales, could cause significant climate variations and add measurably to global warming.

# Mission Overview

AcrimSat is planned to circle Earth for five years as it studies the Sun's energy output. The satellite will make daily measurements of solar radiation incident on Earth's atmosphere with uniform sensitivity from the far-ultraviolet to the far-infrared wavelength range.

**Launch site**

Vandenberg Air Force Base stands on 98,400 acres (39,800 hectares) of what was once open grazing land for wild game and cattle on California's central coast some 140 miles (225 kilometers) northwest of Los Angeles. In 1941, the U.S. Army established a training center for armored and infantry troops called Camp Cooke that operated during World War II and the Korean War. In 1957, the facility was transferred to the U.S. Air Force and acquired its present name. In the decades since, it has served as a staging ground for ballistic missile tests as well as the launch of space-bound rockets. Today the base is operated by the Air Force Space Command's 30th Space Wing.

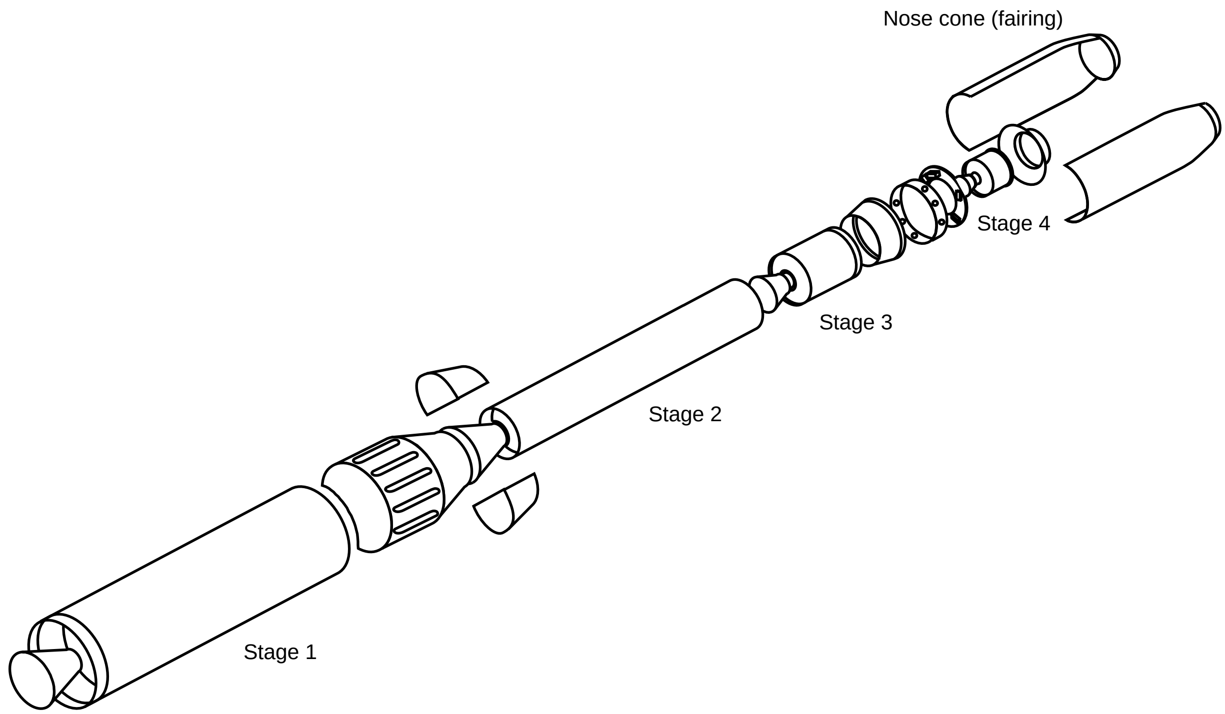
Vandenberg's location, with a stretch of clear ocean for thousands of miles to the south, makes it ideal for the launch of satellites that are designed to orbit Earth in so-called "polar" orbits from north to south. The base has eight active launch pads for Atlas, Delta, Titan, Taurus and other rockets.

**Launch Vehicle**

The Taurus rocket is a four-stage, ground-launched vehicle derived from the Pegasus family of launch vehicles. Taurus is a medium-lift vehicle capable of placing substantial payloads of up to 900 pounds (405 kilograms) in geosynchronous tranfer orbits and up to 3,000 pounds (1,350 kilograms) into a variety of low-Earth orbits. The vehicle is also capable of sending spacecraft into planetary trajectories. (The vehicle's maker, Orbital Sciences Corp., refers to the vehicle's segments as stages 0 through 3; here they are called by the more normal designations of first through fourth stages).

The launch vehicle, first used in 1994, is transportable and can be assembled and launched within a month of arrival at simple, unimproved concrete launch pads. The Taurus can be launched at the U.S. Air Force's Western Range at Vandenberg Air Force Base, CA, the Eastern Range at Cape Canaveral, FL, and at NASA's Wallops Island Range, VA.

Fully fueled on the launch pad, the rocket is 91.4 feet (27.88 meters) high, 93 inches (2.36 meters) in diameter and weighs 159,500 pounds (72,500 kilograms). fairing envelope on a dual payload fairing stands 11.25 feet (3,429 centimeters) tall. The Taurus' primary payload, the Korea Multi-Purpose Satellite, is stacked on top of AcrimSat within a nose cone or fairing that is 11.25 feet (34.29 meters) tall.




*Taurus launch vehicle*

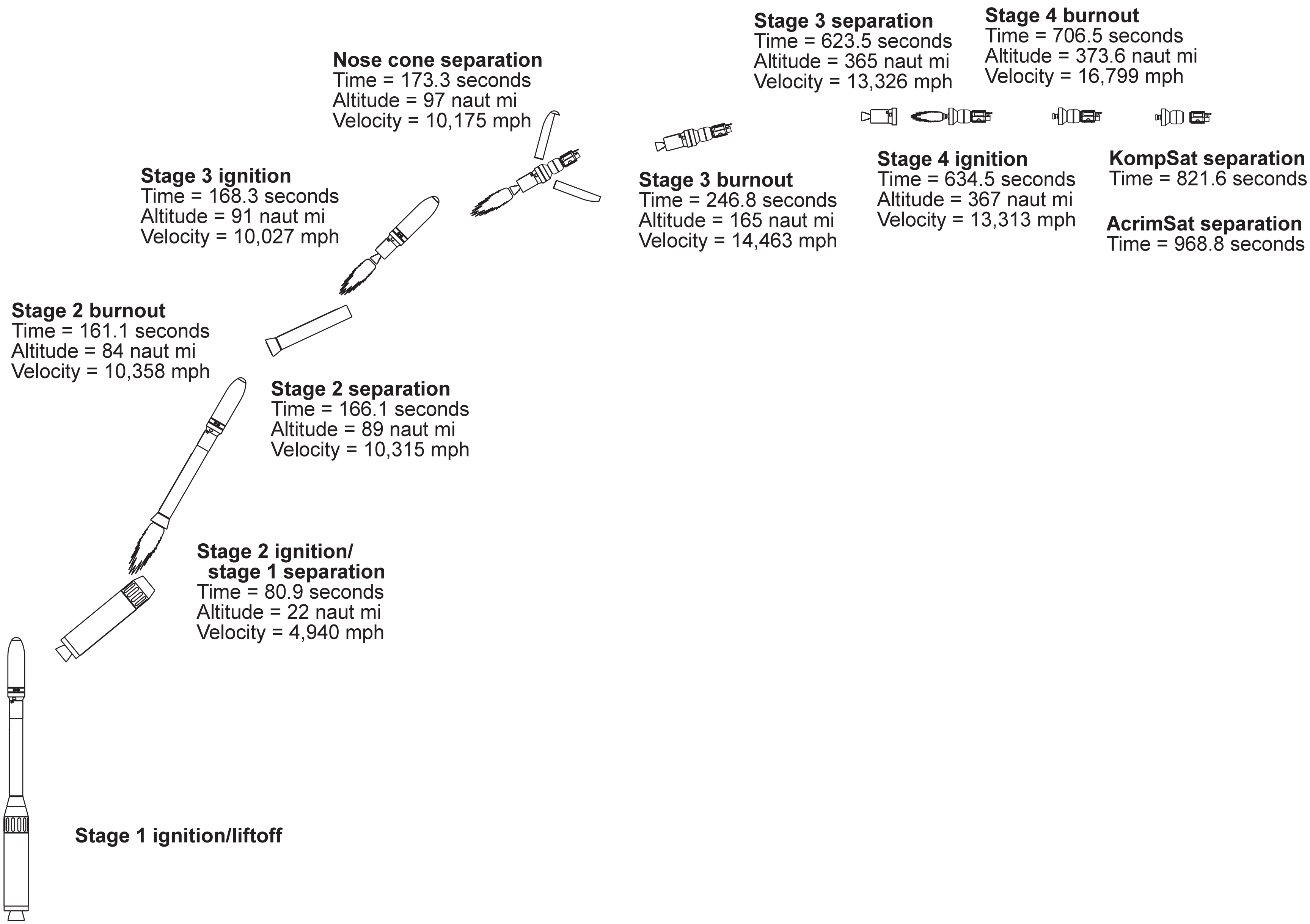
**Launch Timing**

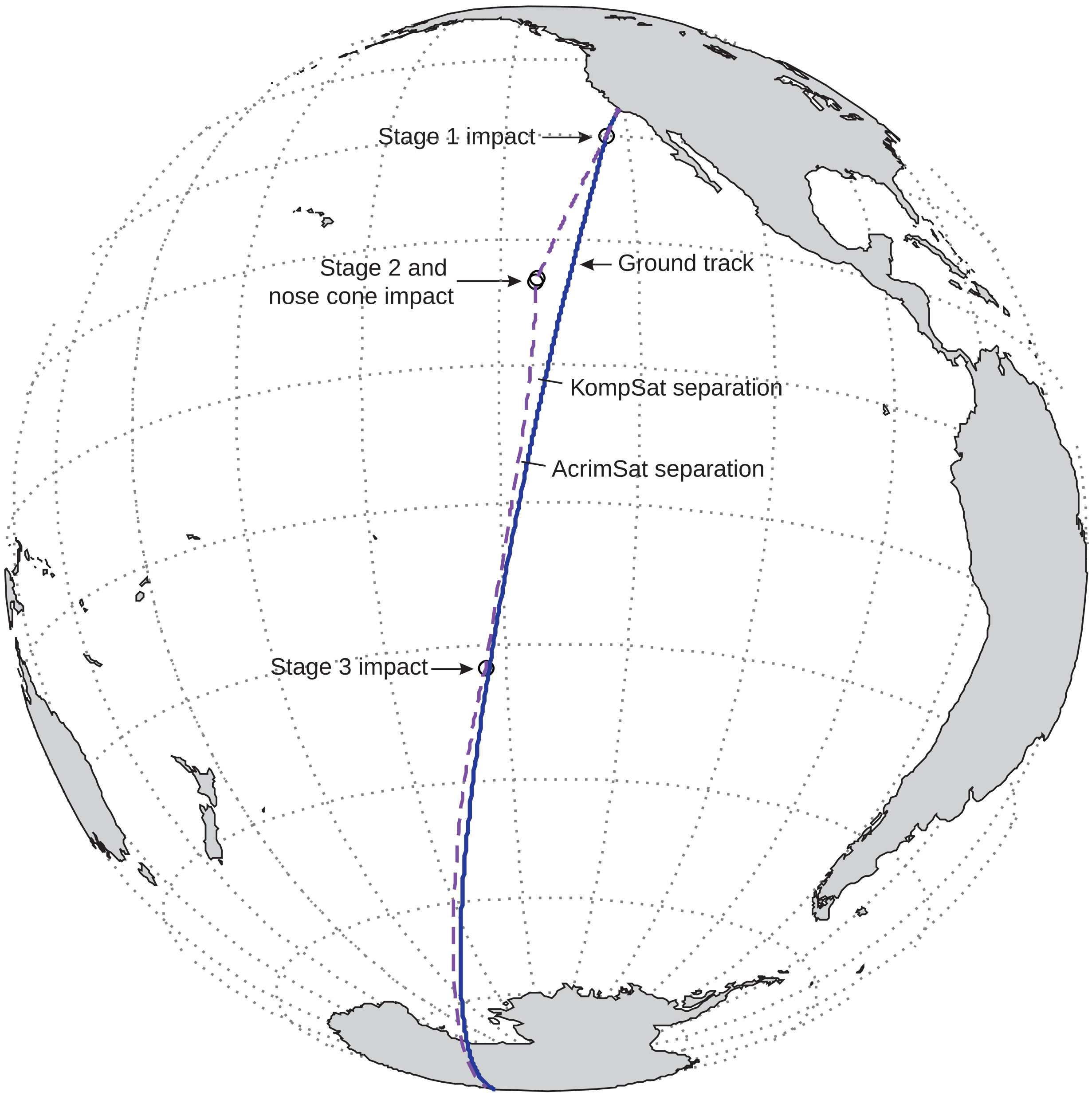
Unlike spacecraft sent to other targets in the solar system, the launches of Earth-orbiting satellites such as AcrimSat do not need to be timed based on the alignment of the planets. The launch date is based only on the readiness of the satellite, the Taurus launch vehicle and the launch range at Vandenberg Air Force Base.

Earth-orbiting satellites do, however, need to be launched during particular windows within any given 24-hour day in order to achieve the proper orbit around Earth. AcrimSat will assume what is called a "Sun-synchronous" orbit flying close to Earth's north and south poles. This keeps the solar panels illuminated but leaves other parts of the spacecraft in the protective darkness of Earth's shadow. In order to achieve this orbit, the satellite must be launched during a 16-minute window that opens at 11:07 p.m. Pacific Standard Time on December 20, 1999. If launch does not take place that day, another attempt may be made the following day during a window at the same time.

**Launch Events**

Liftoff will take place from Space Launch Complex 576 East at Vandenberg Air Force Base, CA. After rising vertically, within 15 seconds after launch the Taurus will be soaring


**Stage 1 ignition/liftoff**
**Stage 2 ignition/ stage 1 separation**
Time = 80.9 seconds
Altitude = 22 naut mi
Velocity = 4,940 mph
**Stage 2 burnout**
Time = 161.1 seconds
Altitude = 84 naut mi
Velocity = 10,358 mph
**Stage 2 separation**
Time = 166.1 seconds
Altitude = 89 naut mi
Velocity = 10,315 mph
**Stage 3 ignition**
Time = 168.3 seconds
Altitude = 91 naut mi
Velocity = 10,027 mph
**Nose cone separation**
Time = 173.3 seconds
Altitude = 97 naut mi
Velocity = 10,175 mph
**Stage 3 burnout**
Time = 246.8 seconds
Altitude = 165 naut mi
Velocity = 14,463 mph
**Stage 3 separation**
Time = 623.5 seconds
Altitude = 365 naut mi
Velocity = 13,326 mph
**Stage 4 ignition**
Time = 634.5 seconds
Altitude = 367 naut mi
Velocity = 13,313 mph
**Stage 4 burnout**
Time = 706.5 seconds
Altitude = 373.6 naut mi
Velocity = 16,799 mph
**KompSat separation**
Time = 821.6 seconds
**AcrimSat separation**
Time = 968.8 seconds




*Early flight events*

over the California coastline in a south-southwesterly direction, heading toward space as thousands of miles of unbroken Pacific Ocean pass underneath.

About two minutes and 46 seconds after launch, when the rocket is 100 statute miles (160 kilometers) over San Diego, CA, the Taurus' first-stage engine will separate at an altitude of about 70 miles (112 kilometers) and fall into the sea.  The rocket's second stage will ignite two seconds later, at two minutes and 68 seconds after launch, at an altitude of about 79 miles (126 kilometers).  Three seconds later, as the Taurus crosses over Mexico's Baja California peninsula, the fairing or nose cone carrying the Korea Multi-Purpose Satellite and AcrimSat will open like a clam shell and fall away.

Second-stage separation will occur at about 10-1/2 minutes after liftoff at an altitude of 420 statute miles (672 kilometers) above Earth; the third stage engine will ignite 11 seconds later, at an altitude of 422 miles (1,080 kilometers) above Earth. AcrimSat will deploy its solar panels at about 11-1/2 minutes after launch in preparation for its release.

The Taurus' third-stage booster will then fire for 1 minute and 12 seconds before deploying the primary Korea Multi-Purpose Satellite at about 14 minutes into flight. The Taurus rocket will then be turned to point at the Sun before releasing the AcrimSat at about 15-1/2 minutes into flight, at an altitude of 429 miles (686 kilometers). Once it has been deployed, AcrimSat will begin a nine-minute coast over the Pacific Ocean, heading in a south-southwesterly direction over the Marquesas Islands. By this time, the satellite will be within 10 miles (16 kilometers) of its circular science orbit of 425 by 425 miles (685 by 685 kilometers) above Earth's poles.

About 20 minutes after launch, ground controllers at the McMurdo Ground Station in Antarctica will receive AcrimSat's first signal. The first two-way communication pass, to be conducted from a ground station at Poker Flats, AK, will be carried out about 1-1/2 hours after launch to ensure that the satellite's solar arrays have been properly deployed.

**Fine-tuning the Orbit**

AcrimSat will be released from the Taurus launch vehicle spinning about once per minute, and will spin itself up to about seven revolutions per minute. At this time the spacecraft will also fine-tune its pointing with respect to the Sun. Control of the spinup and pointing

## AcrimSat Launch Events

| *Event Description* | *Time (sec)* | *Altitude (naut miles)* | *Range (naut miles)* |
|---|---|---|---|
| Stage 1 ignition/liftoff | 0.0 | 0.0 | 0.0 |
| Stage 1 separation/ stage 2 ignition | 80.9 | 22 | 32 |
| Stage 2 separation | 166.1 | 89 | 174 |
| Stage 3 ignition | 168.3 | 91 | 179 |
| Fairing (nose cone) separation | 173.3 | 97 | 190 |
| Stage 3 separation | 623.5 | 365 | 1,548 |
| Stage 4 ignition | 634.5 | 367 | 1,580 |
| Stage 4 burnout | 706.5 | 373.6 | 1,820 |
| KompSat separation | 821.6 | 373.6 | |
| AcrimSat separation | 968.8 | 373.8 | |

will be achieved using onboard Sun sensors to detect the position of the Sun, and an onboard three-axis magnetometer to detect Earth's magnetic force lines.

The AcrimSat operations team will monitor spacecraft health via information transmitted from the spacecraft. The spacecraft will be monitored for operating temperature, state of battery charging, Sun-pointing performance and the general state-of-health of all onboard systems.

About two weeks after launch, instrument checkout operations will begin. Each sensor shutter will be operated and solar irradiance data will be collected. The results of the measurements from the instrument's three sensors will be interleaved and the data will be compared to data collected by another Active Cavity Radiometer Irradiance Monitor flying on NASA's Upper Atmosphere Research Satellite at the same time.

Once normal performance of the instrument is verified, two of the shutters will be closed and only one of the sensors will be used as the primary monitoring sensor for normal on-orbit operations.

**Data Gathering and Processing**

When the radiometer instrument fills its internal memory with data, the instrument will transfer that data to the central data storage area in the spacecraft's computer. The combination of instrument and spacecraft state-of-health data accumulated in one day will equal approximately 1 megabyte of information, or the amount of information that would occupy slightly less than the storage space of a floppy disk used in a personal computer. The spacecraft will be able to store three days worth of data before it starts to lose information due to a lack of storage space.

Each day the AcrimSat ground station will contact the spacecraft and issue a command to transmit the data stored onboard to the ground station. The primary ground station is located at the Jet Propulsion Laboratory's Table Mountain Observatory near Wrightwood, CA. The satellite can also use backup ground stations facilities in Poker Flats, AK, Wallops Island, MD, Svalbard, Norway and the McMurdo Ground Station in Antarctica, all of which are managed by NASA's Wallops Flight Facility, Wallops Island, VA. These stations have recently been updated and are now completely computer-controlled without human operators. The stations at Poker Flats, Svalbard and Wallops Island use dish antennas 37 feet (11.3 meters) in diameter, while McMurdo is equipped with a dish antenna 33 feet (10 meters) in diameter.

Once the data have been transmitted to the ground, they will be sent via a NASA closed network to the AcrimSat Mission Control Center at JPL for primary archival storage. From JPL, the data will be transferred over the Internet to the Columbia University Science Computing Facility operated by the principal investigator in Coronado, CA.

The mission's principal investigator will be responsible for data processing and analysis. He will then send the final total solar irradiance science data products to the Earth Observing

System's Radiation Data Analysis and Archiving Center at NASA's Langley Research Center in Virginia. The data stored in the NASA Earth Observing System's Langley data archival center will be available over the Internet to all researchers.

**The Korea Multi-Purpose Satellite**

The Korea Multi-Purpose Satellite (KOMPSAT), a small, light-weight satellite designed by TRW Inc., Redondo Beach, CA, is the primary payload aboard the Taurus launch vehicle and the centerpiece of a program intended to cultivate Korean engineering expertise and give that country operational experience in the space arena. The flight satellite was built by TRW Inc. and was assembled in Taejon, South Korea.

Sponsored by the Korea Aerospace Research Institute (KARI), the multi-purpose satellite houses instruments to map Korea, monitor ocean color and Earth resources, and perform space physics experiments. A high spatial resolution visible imaging sensor for cartography and an ocean color imaging camera were supplied by TRW. Two instruments to study the space environment were provided by KARI and the Korea Advanced Institute of Science and Technology (KAIST) in Taejon, South Korea.

# The AcrimSat Instrument

The objective of the AcrimSat instrument is to monitor the total solar irradiance with state-of-the-art precision over five years, as the Sun reaches the peak of its activity cycle. The instrument measurements are designed to provide new insights in the fields of climatology and solar physics.

The AcrimSat instrument and spacecraft represent a unique, new capability for NASA research. The instrument is lighter and more compact than its predecessor by a factor of more than two. This allows the radiometer to be flown in a small, dedicated spacecraft like the AcrimSat. The satellite/radiometer combination is small enough to be easily launched as a secondary payload on any of an array of boosters, providing its sponsors with the flexibility of numerous launch opportunities while keeping launch costs to a minimum.

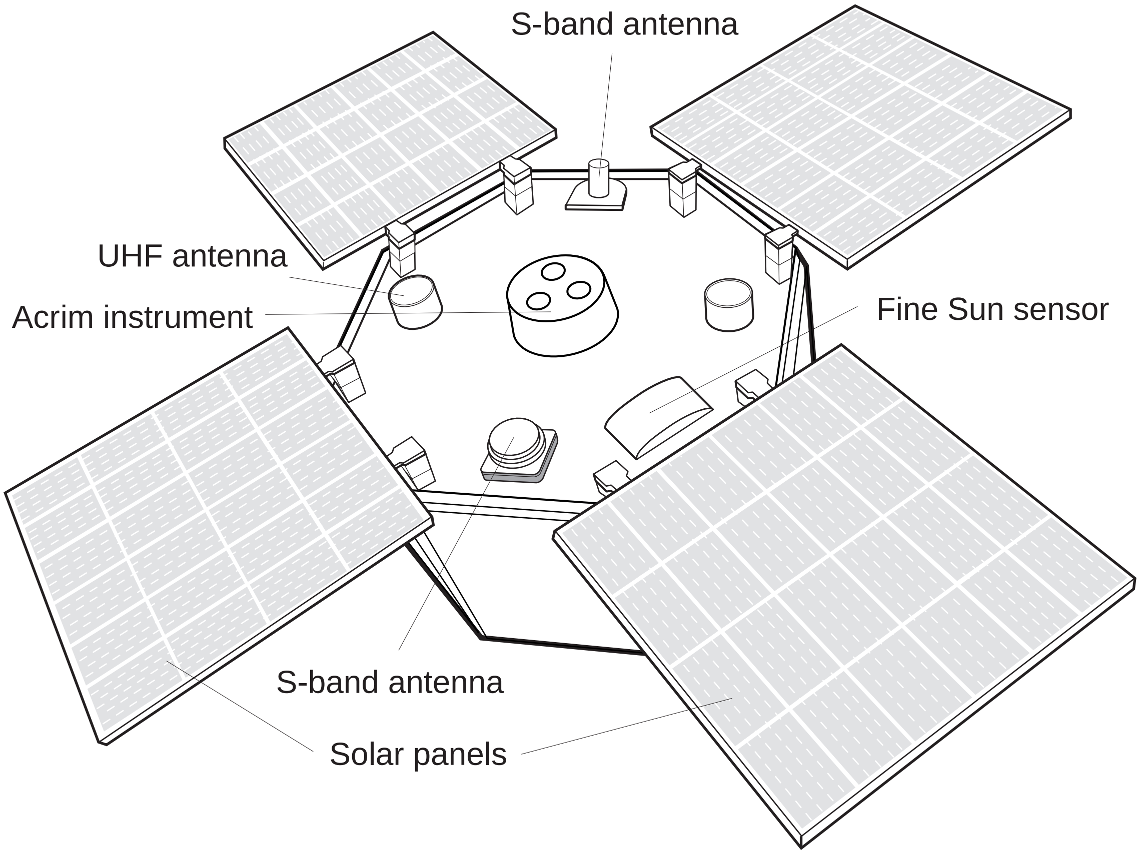
The active cavity radiometer instrument is designed for precise, continuous measurements of total solar irradiance in spaceflight experiments and is capable of measuring solar energy in the far-ultraviolet to far-infrared wavelength range. The instrument includes three identical active cavity radiometers that are used in different cycles. One monitors the Sun all the time. Data from the second instrument will be compared to data from the first instrument once every few months. The third sensor's data will be used as a comparison with the first and second instruments' data once every two months. With this rotating system of data comparison, anticipated slow changes in the first sensor, caused by exposure to the Sun and space, will be calibrated and removed from its measurement results.

The principles governing active cavity radiometers were developed by the AcrimSat principal investigator at JPL during the 1960's and 1970's. An electronic system maintains the temperature of the active cavity radiometer cavity constant over a shutter cycle by providing electrical heating. When the shutter is closed over the cavity, electrical heating alone maintains the temperature. When the shutter is open, solar irradiance is absorbed by the cavity and the electronics decrease the amount of electrical heating automatically to maintain constant temperature. The difference in electrical heating between the shutter open and closed phases is proportional to the amount of solar irradiance incident on the radiometer.

## AcrimSat Science Team

Dr. Richard C. Willson, Center for Climate Systems Research, Columbia University, Coronado, CA, *Principal Investigator*

*Co-Investigators:*
Dr. James Hansen, NASA Goddard Institute for Space Studies, New York, NY
Dr. Alex Mordvinov, Institute of Solar-Terrestrial Physics, Russian Academy of Sciences, Irkutsk, Russia
Dr. Hugh H. Hudson, Solar Physics Research Corp., Tucson, AZ




*AcrimSat spacecraft*

The "active" electronic maintenance of cavity temperature gave rise to its name; it is an "active" cavity radiometer rather than a passive cavity radiometer. The active mode of operating this type of solar irradiance sensor, known generically as a pyrheliometer, was a technological breakthrough in providing high accuracy and precision for solar measurements. The approach has since become the international standard for this type of measurement.
Electrical connections to the AcrimSat are made through a remote interface unit on the satellite bus. Commands to, and all data from, the active cavity instrument are transmitted via this remote interface unit.

# Program/Project Management

The flight hardware and mission operations activities of the AcrimSat mission are managed for NASA's Earth Sciences Enterprise, Washington, DC, by the Jet Propulsion Laboratory, Pasadena, CA. The science investigation is managed by the Center for Climate Systems Research, a cooperative venture of Columbia University and NASA's Goddard Institute for Space Studies, New York, NY.

At NASA Headquarters, Dr. Ghassem Asrar is the associate administrator for the Earth Sciences Enterprise. Dr. Jack Kaye is director of the Earth Sciences Enterprise's Research Division, and Dr. Robert Curran is program scientist.

At the Jet Propulsion Laboratory, Ronald Zenone is the AcrimSat project manager. Roger Helizon of JPL is the AcrimSat instrument scientist. JPL is a division of the California Institute of Technology, Pasadena, CA.

Dr. Richard Willson of Columbia University, New York, NY, is the principal investigator. Tom Itchkawich of Orbital Sciences Corp., McLean, VA, is the company's AcrimSat program manager.

12-17-99 HQ